

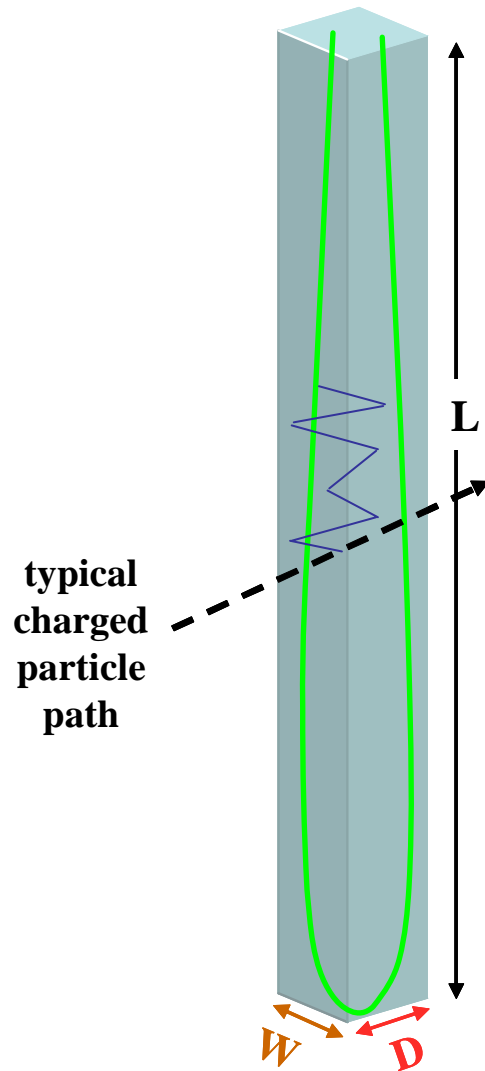
# Electronics/DAQ

## WBS x.6, x.7

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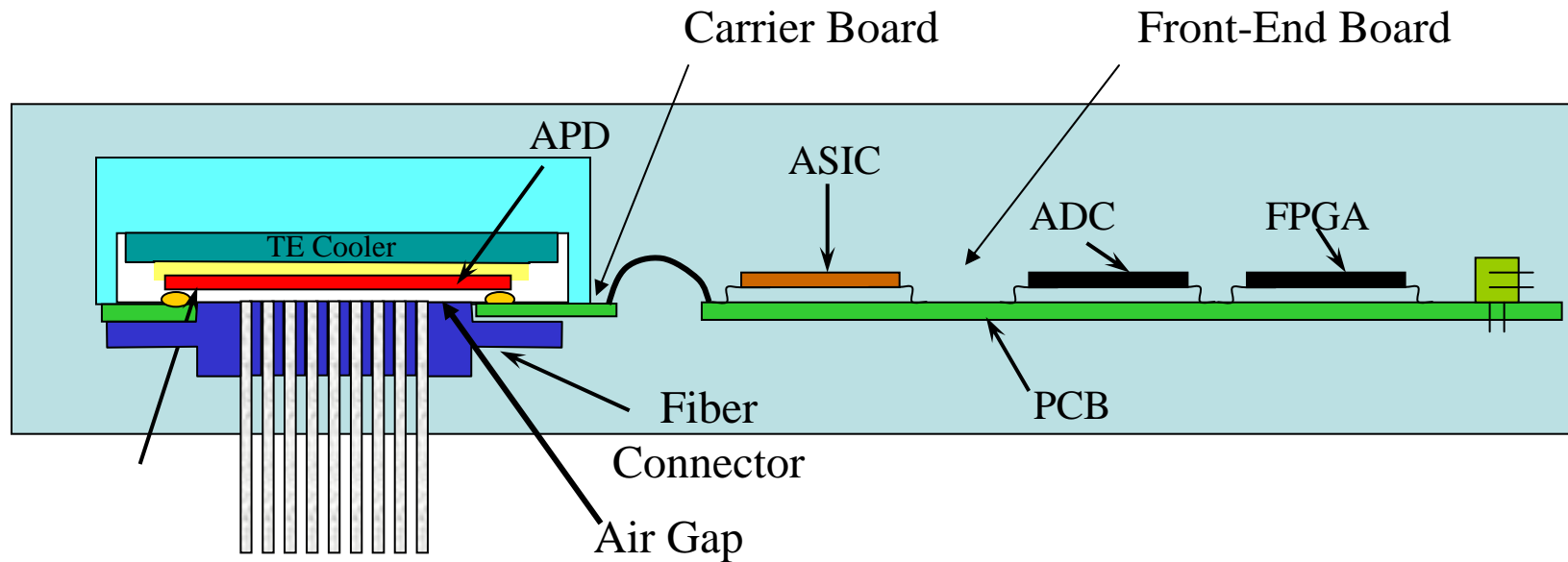
# The Basic Detector element

To 1 APD pixel



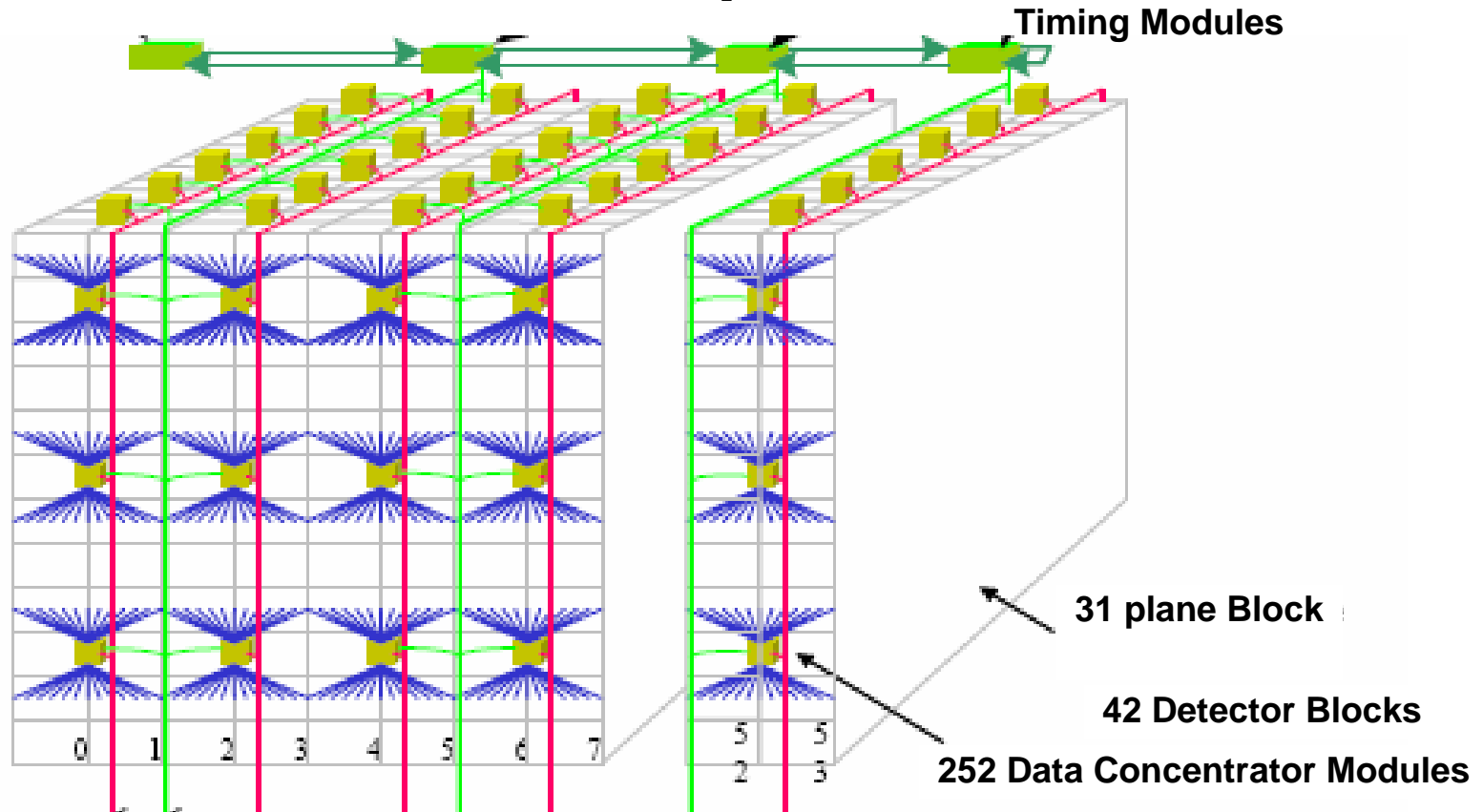
- Liquid Scintillator
  - 5.5% pseudocumene as scintillant
  - Mineral oil and waveshifters (PPO, bis-MSB)
- PVC cell for primary containment
  - Horizontals: 3.87 cm x 6.0 cm x 15.5 m long, 3 mm walls
  - Verticals: 3.76 cm x 5.7 cm x 15.5 m long, 4.5 mm walls
  - So outside dimensions of both types are identical.
  - Highly reflective, 15% titanium dioxide
  - Diffuse reflection keeps light local to track along the cell length to  $\pm 25$  cm
    - $\sim$  cosine (angle to normal to wall)
- Looped wavelength shifting fiber to collect light
  - 0.8 mm diameter, double clad, K27 waveshifter
- Avalanche Photodiode
  - 85% quantum efficiency @ 500 – 550 nm
- Low noise amplifier

# Electronics Components



- Photo Detector
  - APD detector –Mualem,Rusack Univ. of MN
  - Housing –Mufson,Urheim Indiana University
- Front-End Electronics
  - ASIC –Yarema,Zimmerman, FNAL
  - Front-End Board –Oliver,Felt, Harvard University
- Power Distribution –Dukes, Univ of VA

# DAQ Components

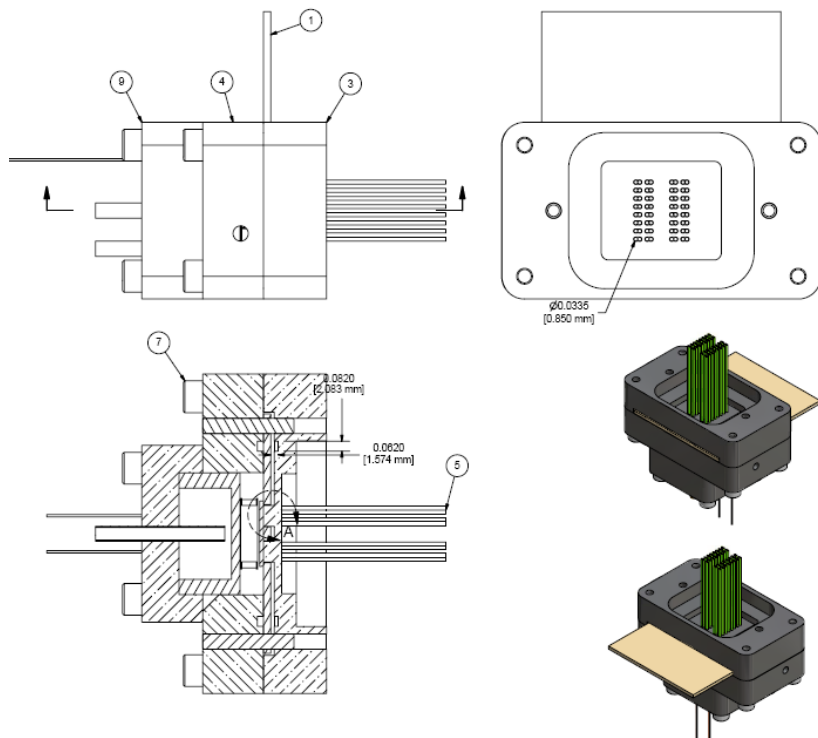


- Data Concentrator
  - Kwarcianny, FNAL
- Timing Distribution
  - Haynes, FNAL
- Buffer Farm
  - Kwarcianny, Pavlicek, FNAL
- DAQ Software
  - Guglielmo, FNAL

# Photo Detector

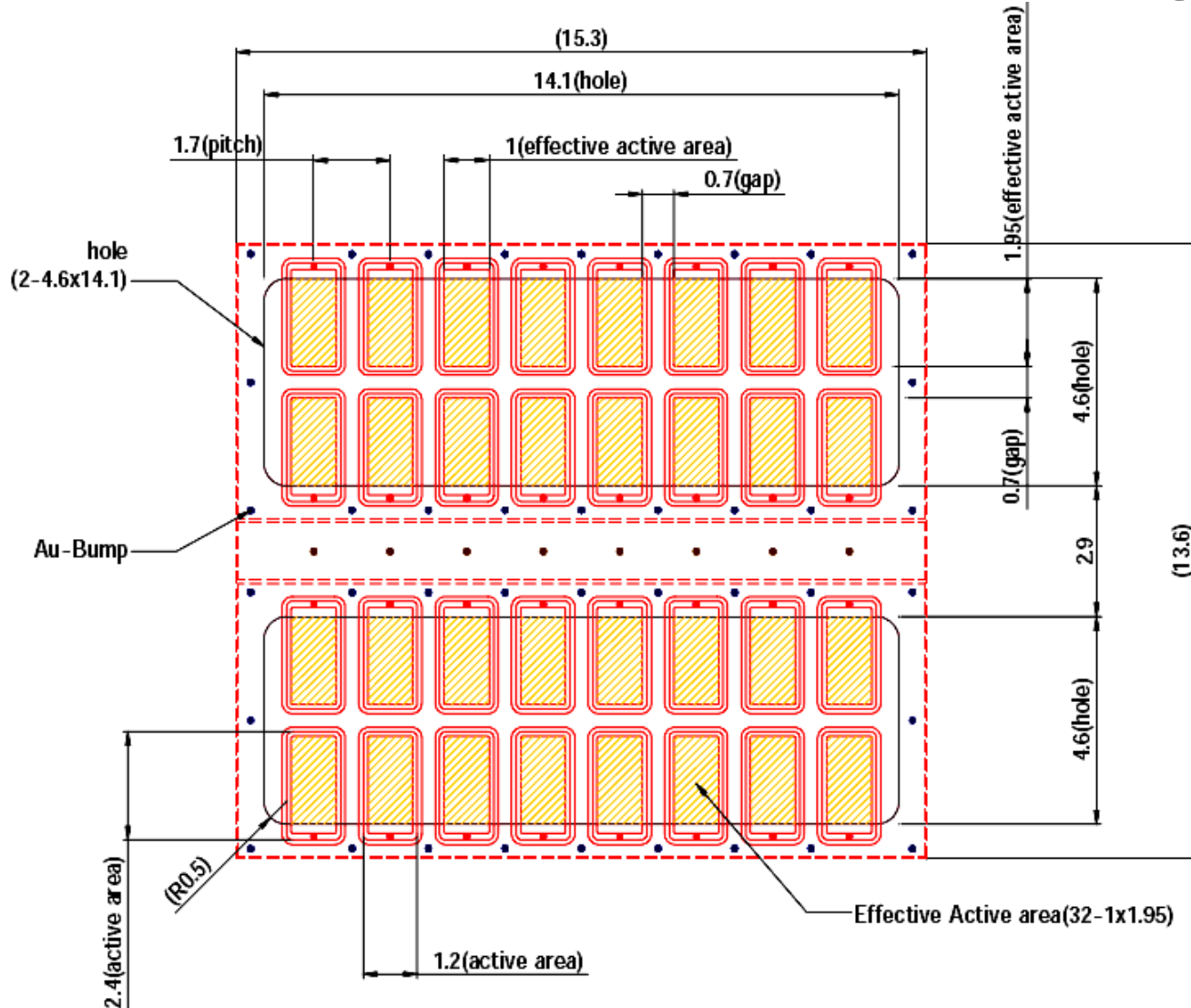
- Tested Commercial Unit, Hamamatsu S8550 for operating characteristics, gain, stability, QE, leakage, dark current.
- Working on delivery of custom unit delivery now scheduled for mid-December
- Tested characteristics of prototype housing, containment, cooling, heat removal for single module.
- Global heat removal system designed, beginning prototype stage

# IU Containment/Cooling Prototype

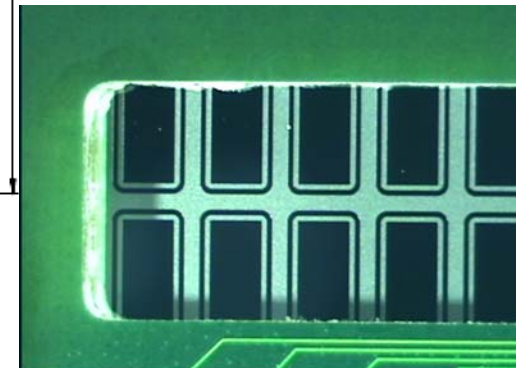


- Used to measure heat load for cooling APD
- Prototype of water cooled heat sink
- Basic design is functional, now redesigning to fit constraints of the detector.

# APD Mounting



- Optimized for 2 fiber mounting
- Industrial Si mounting (Flip-Chip)

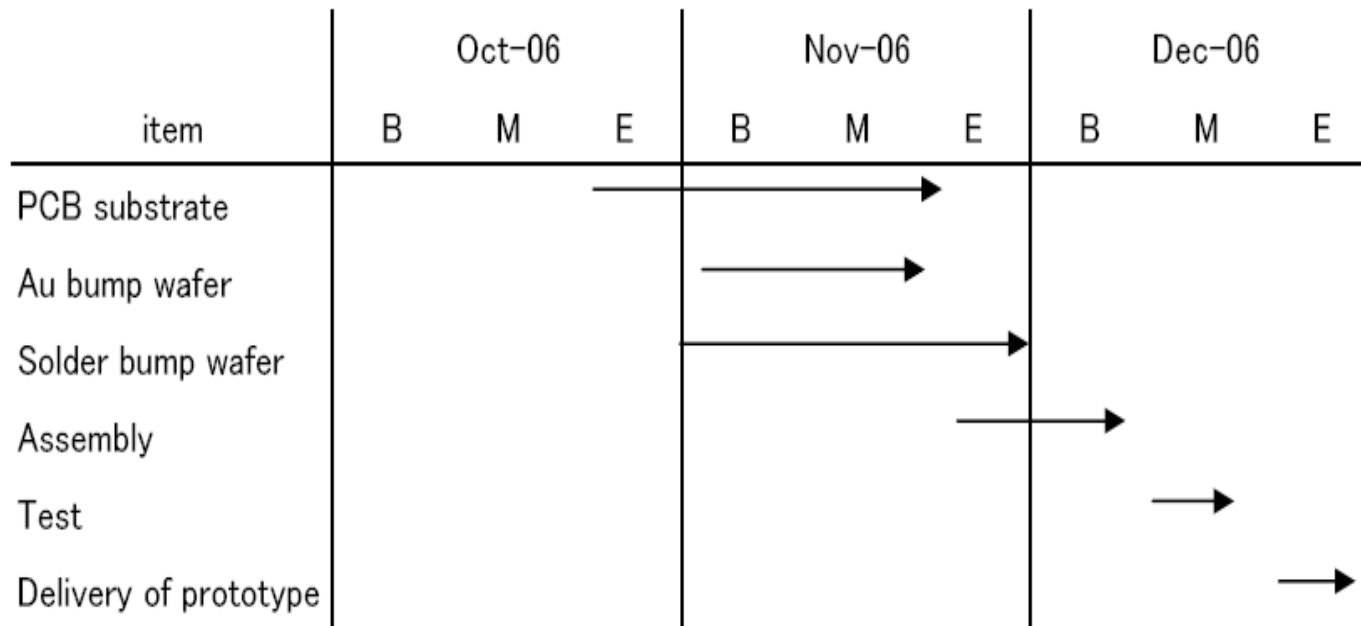


# Not Without Problems

- There were issues
  - Unknown Design Constraints
    - Harvard, IU do mechanical/electrical design
  - Flatness
    - Spec with Manufacturer, Hamamatsu loosens spec
  - High Temperature process (350°C)
    - Find compatible material (Nelco 4000-13)
  - Bondability
    - Use Hamamatsu's Supplier



# Hamamatsu Schedule



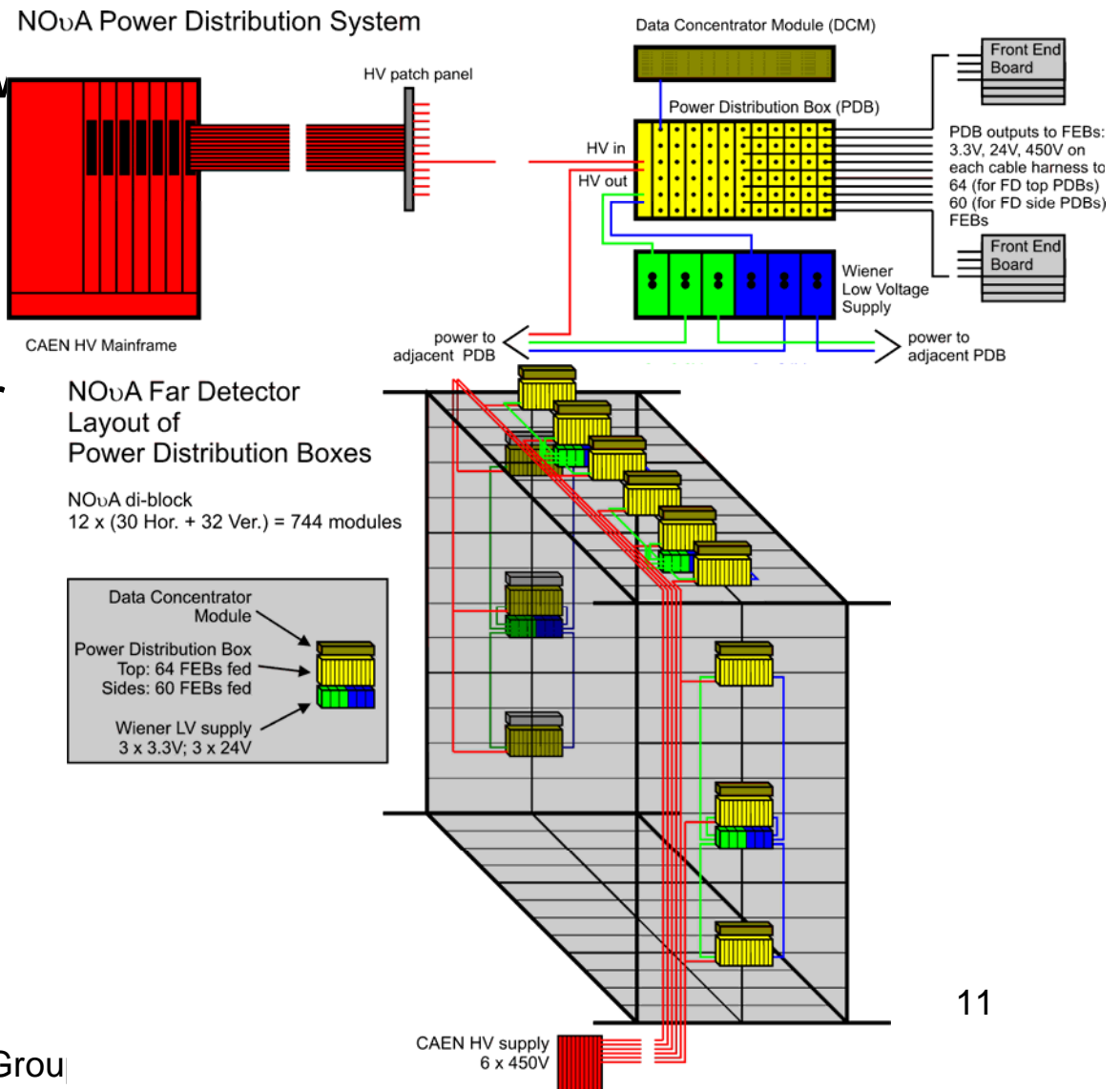
- **October 30 Meeting Results**
  - Showed dummy arrays strongly bonded to PCB substrate
  - Gold Bump Wafer Already Produced
  - Substrate in production, arrival imminent
  - Delivery in Mid-Late December

# Front-End Electronics

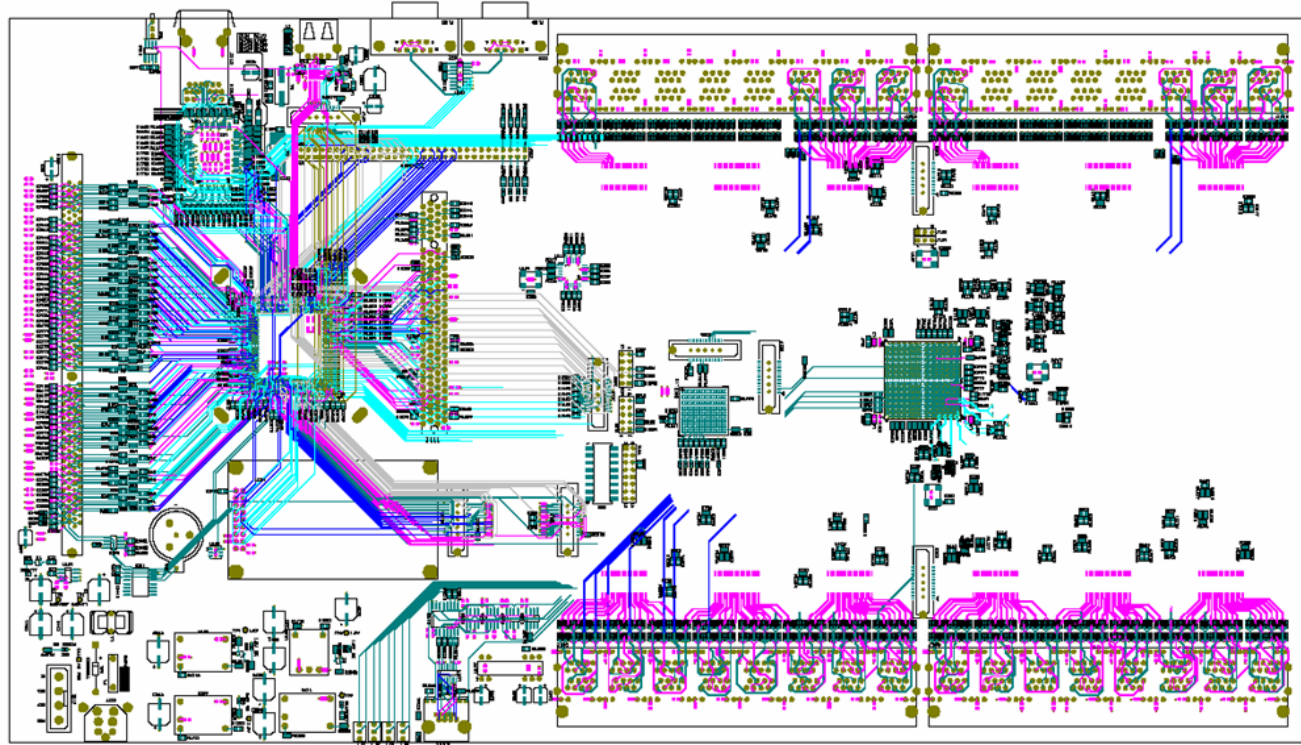
- ASIC designed --Zimmerman
- ASIC prototyped and tested --Zimmerman
- Fully functional, lower noise than simulated, ~100 electrons for 1us dual-correlated sampling. (Expected 150)
- ADC tested/qualified --Harvard
- FPGA DSP algorithms developed --Harvard
- Upstream data format and protocol defined
- Still need to put ASIC, ADC, and FPGA together
  - Board out for production this week, preliminary results in 1 month, final results in 2 months.

# Power Distribution

- Design uses Wiener low voltage power supplies
- Distribution more widespread than typical
- Remote control and monitoring important for large remote site.
- On-board subregulation should minimize noise
- CAEN High Voltage supplies.
- Full design well underway



# Data Concentrator Module



- Design complete
- Layout complete
- Review next week
- Board out for production week after
- Firmware under development

Mualem NOvA Working Group Nov. 16, 2006

# Timing/Command System

- Timing system under design
- GPS systems identified
- Synchronization scheme under test

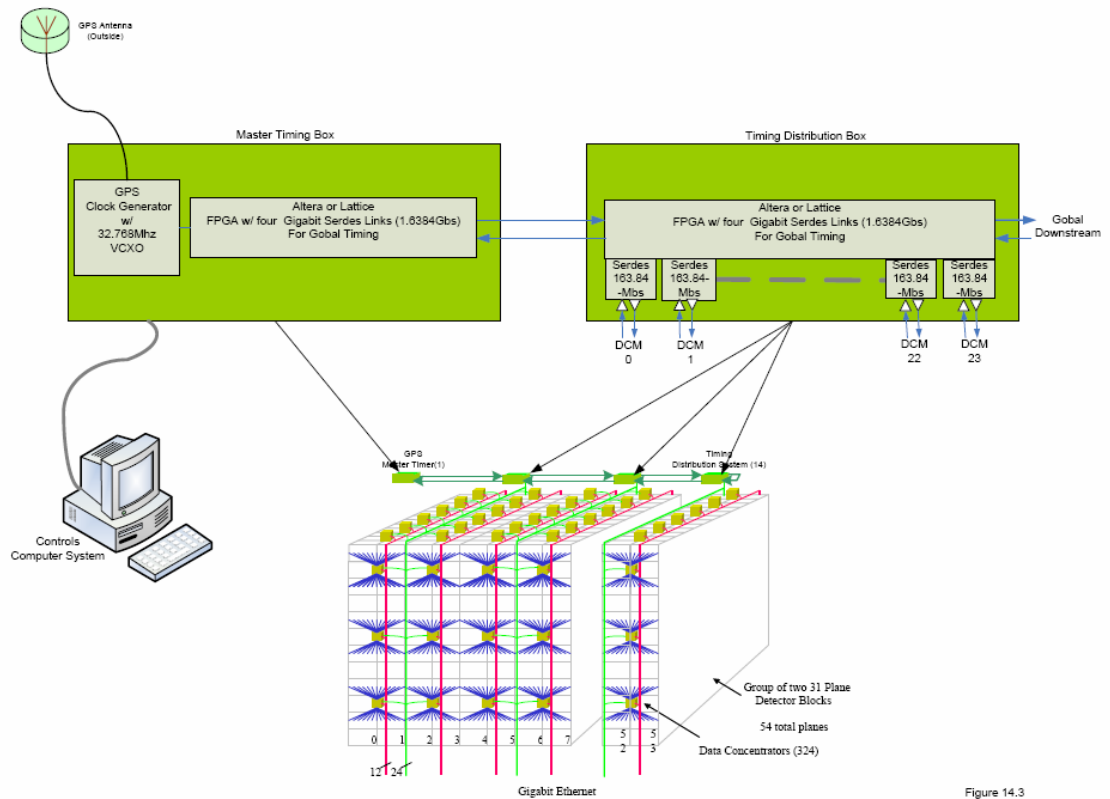


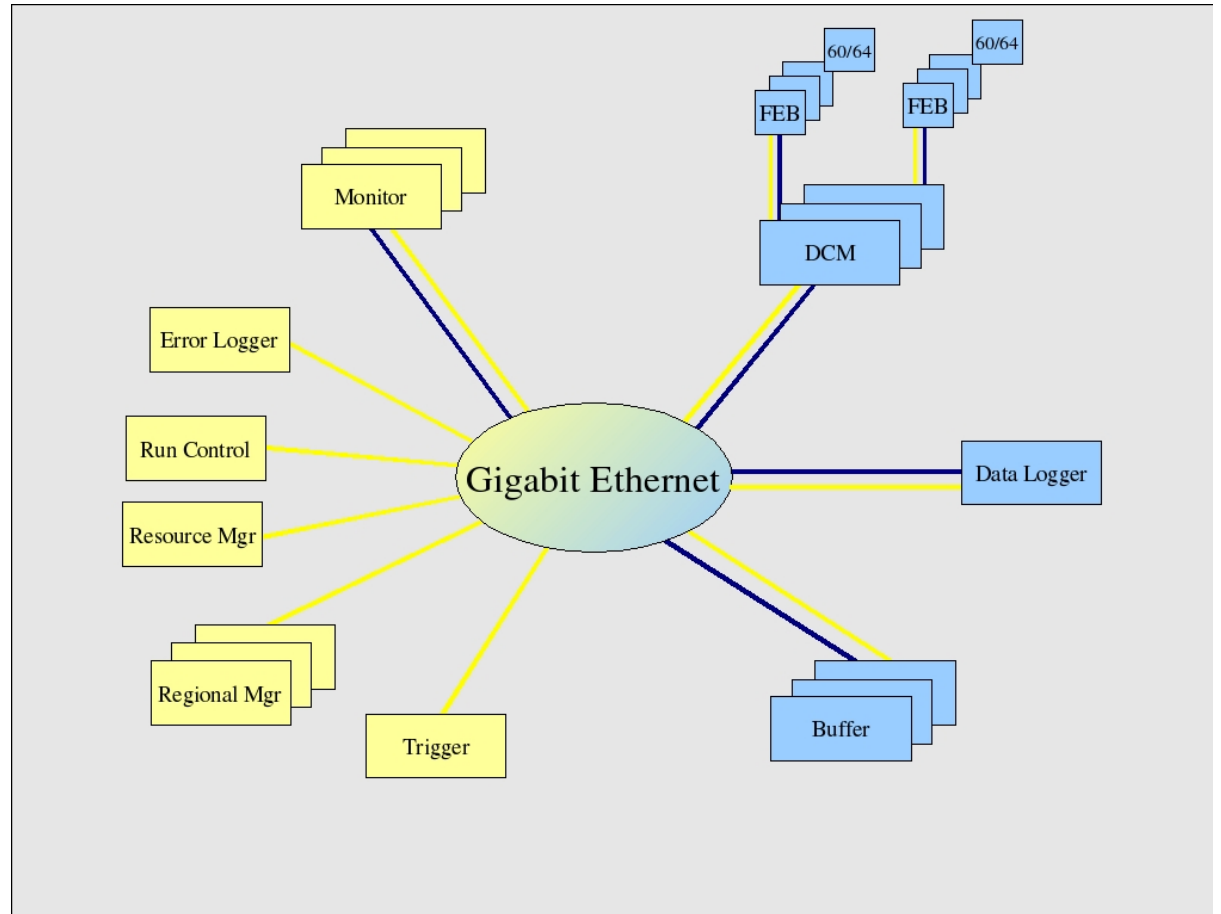
Figure 14.3

# Buffer Farm, Gbit network

- Uses 192 commodity PCs to buffer data for 20s to wait for spill signals
- 33 commodity switches for interconnection of 252 DCMs to 192 buffer farm nodes

# DAQ Software

- Manages DCMs
- Buffer Farm
- Run Control
- Trigger Distribution
- Error reporting
- Monitoring
- Data logging



# DAQ Software Status

- Currently marching through myriad tasks to get an efficient and robust system up and running for IPND
  - Coding standards NOvA-Doc-615
  - System overview NOvA-Doc-1233
  - Message passing
  - Trigger search algorithms
  - Buffering performance
  - ...



# System Integration Tasks

- APD-FEB
  - Tests Noise, performance of ASIC
- FEB-DCM
  - Tests Protocol, System Design
- DCM-Buffer Farm
  - Tests DAQ Software, DCM Algorithms
- APD-FEB-DCM-  
Buffer Farm- Permanent Storage
  - Tests Full Data Path

# Conclusions

- Prototyping and testing of critical components is nearly complete, Custom APD being the notable exception
- Integration of components at the next stage will give a clear picture of how the system will perform, in terms of noise for the electronics and bandwidth for the DAQ
- Interconnection of the major systems will then test the complete system design